REMEMBERING CHANDRU

THE MAN, HIS PHILOSOPHY AND SCIENCE

FROM ALL HIS FRIENDS, COLLEAGUES AND STUDENTS

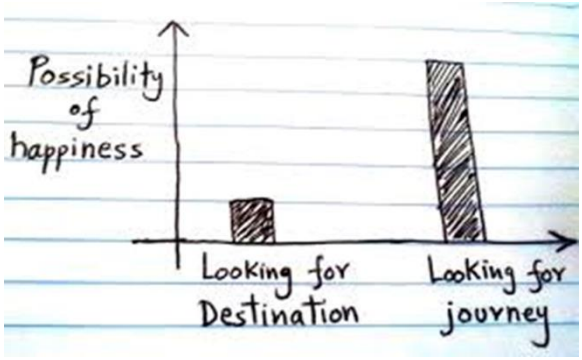
ANINDYA SINHA AND R UMA SHAANKER

"One of the deep secrets of life is that all that is really worth the doing is what we do for others." These unusually prophetic words from none other than Lewis Carroll were the first to strike us, when we heard of the untimely passing away, at a relatively young age of 63, of one our closest friends, a dear friend to all who knew him – student, teacher or fellow researcher – K Chandrashekara or "Chandru", as he was affectionately known to us. And there is no exaggeration in our deep belief that Chandru was easily one of the most inspiring figures that the student community of Bangalore, in the field of entomology, looked up to, and, at the same time, a most endearing individual with an uncanny ability to bond with all and sundry. It was very common for Chandru to exchange pleasantries with a smile and hit upon an interesting conversation, not necessarily academic, with anyone that he met, from any walk of life. And that is his legacy, what Chandru would have possibly liked to be most remembered for – an inordinate love for science (for beetles too, of course, as it was for one of his heroes, J B S Haldane), for nature, for people, for the sheer wonder of being alive!

As long as can be remembered, the duo of K N Ganeshaiah and R Uma Shaanker were Chandru's sounding boards, academic colleagues and fast friends, animatedly inspiring Chandru to reach heights during his doctorate and his long faculty tenure at UAS. This association brought together some of the best minds immersed in a heady mix of natural history, taxonomy, ecology and evolutionary biology, and culminated in some seminal and thought-leading scientific work. This was at a time when ecological research in the country was still in its infancy.

Anindya Sinha was one of Chandru's closest colleagues and friends, and they both collectively illuminated the already stellar intellectual aura of CES. In his own words, " I would never even dreamt that one day, I would be called upon to write about Chandru. But somewhere deep down inside, I want to share Chandru with the whole world. He was after all a universal human being, the world was his oyster. His contributions to science, to academics, to his students, who loved him so much, were so subtle, just like the man he was."

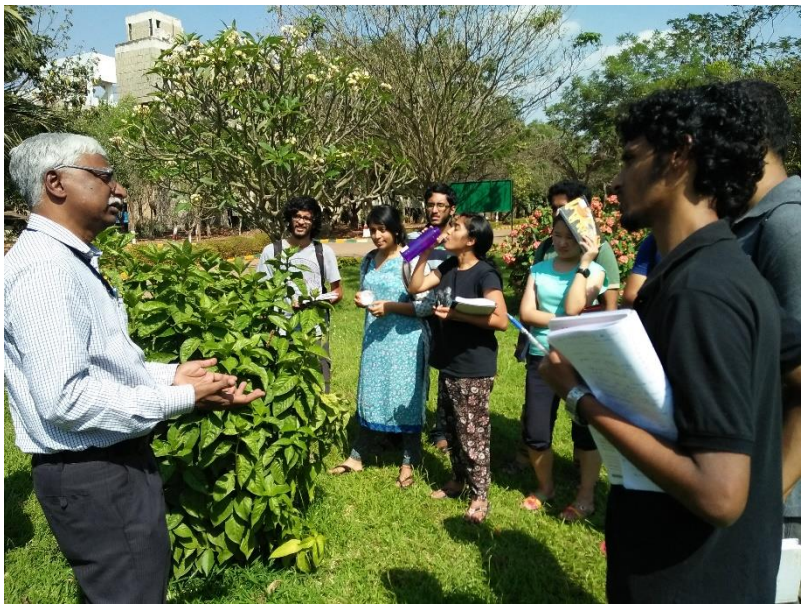
We had known Chandru from the mid-1980's, since when he became a doctoral student at the Centre for Ecological Sciences (CES) at the Indian Institute of Science in Bangalore. We cherish the times when he would take us to the India Coffee House and share snippets of his work and listen attentively to our responses. What we remember most was the joyful smile with which Chandru always greeted us – it is remarkable how much others' happiness moved him and the extent to which he cared for his friends.



Chandru's doctoral research was unique in examining the social organisation and individual behavioural profiles of female wasps of the species *Ropalidia marginata*. He conducted elegant statistical analysis of their time-activity budgets and discovered three behavioural castes, with striking differences in the division of labour between them. What Chandru was able to conclusively establish, in the course of his studies, was that effective division of labour and a supportive social organisation had been achieved through a remarkable process of behavioural caste differentiation and not, as in many other primitive wasps, through a dominance hierarchy led by a despotic queen suppressing all her nestmates into worker roles. This thus suggested that behavioural patterns in such primitively eusocial insects were likely to be moulded by a complex interaction between selection at the individual and colony levels.

Chandru did not merely stop here but successfully addressed a great variety of problems with his typical versatility and in collaboration with many of his colleagues, while he was at CES. These included the development of sampling methods to evaluate insect species diversity in the tropics, an extensive exploration of ant species richness and diversity in the Western Ghats, and studies relating to dominance relationships, regulation of foraging and worker activity, serial polygyny and its implications for the evolution of eusociality, and inter-individual genetic relatedness in *R. marginata*. It was at this time that we made an interesting, though fortuitous, discovery: a single colony of a behaviourally unknown species of what seemed to be a rather primitively eusocial wasp, *R. rufoplagiata*. Chandru, with his unique enthusiasm and skill, collected the colony with great care, transplanted it to the vespiary on the terrace of the erstwhile CES building, pored through dusty colonial zoological records to identify the species and thus led us on a voyage of discovery in behaviourally characterising and describing the unusual life-history strategies of this unique wasp species. Looking back, it was not only the thrill of getting to know a 'new' species through the steps of the scientific method, initiated by Chandru, which made it all worthwhile but also his unbridled enthusiasm and generosity of spirit that was so inspirational, so emotionally moving.

When he joined the University of Agricultural Sciences (UAS) as a young faculty, Chandru's attention was naturally drawn towards courses on insect ecology and behaviour; he developed these two courses with right earnestness and began to offer them to willing students, a process that he continued for years on end, his last lecture being as recently mid-March. Chandru's lectures were a delight to listen to, sprinkled most generously with loads of anecdotes and, of course, with his typically rich insights.



One doctoral student in plant biology even registered for Chandru's course on insect behaviour, simply because she found in him a person who wished to communicate the excitement of doing science!

For Chandru, it was extremely important to share with all the enjoyment of learning the secrets of nature that research had helped unravel. Although these mysteries could be shared by informal and formal communication, through seminars or publications, Chandru always preferred the informal to the more formal approaches. He said that he would rather chat for hours and share science over coffee than give lofty lectures or write eruditely about scientific discoveries. While he certainly did not have the patience for the latter, he did spend long coffee times with students – and today, we realise that

Chandru will long be remembered, not for his scientific discoveries or publications alone but for reinforcing, almost singlehandedly and perhaps unconsciously, the old, historic Indian tradition of storytelling and of oral communication of pure knowledge across generations.

With research interests largely focussed on insect ecology and evolutionary biology, Chandru worked extensively and tirelessly on dung beetles, ants and, of course, wasps. He helped develop a new and improved method of quantifying species diversity of insects and was amongst the first to demonstrate the use of the niche modelling to predict the spread of important agricultural pests. He also became interested in bioprospecting venom peptides from the venom glands of a number of insects, especially hymenopterans, collaboratively aiding in the description of several novel anti-microbial peptides from ants, bees and wasps. All these explorations were so typical of Chandru's quietly adventurous, scientific spirit.

Chandru's amazingly persistent efforts, often against the tide, led him to establish an interdisciplinary School of Ecology and Conservation at UAS, with students working on a range of cross-cutting themes, including ant foraging behaviour, plant-fungal interactions or plant-insect interactions. None of this would have been possible without Chandru's deep love for these disciplines and his farsighted concern that students must be made aware of the importance of fundamental biological knowledge in the development of applied disciplines, such as agricultural entomology.

Chandru had an irresistible urge to initiate discussions and seminars on just about anything that he considered good science and with which he could effectively engage his students. His meetings were typically a watershed in the sheer intensity, and the length and breadth to which different topics would be

discussed by a rather breathless Chandru. These were all made possible, of course, by a most wonderful habit of his, especially in today's times: his obsessive urge to read, extensively and voraciously, whatever he could lay his hands on. But what always amazed us was his capacity to do this even under the most trying circumstances. In September 2018, for example, while battling a serious lung ailment in hospital, Chandru reflected on and wrote to us about the remarkable plasticity of the brain, development of a gender-specific lexicon in humans and gene-culture coevolution in our populations! But it is not for this reason alone that he will be sorely missed by his friends and colleagues. It is true that his love for knowledge was insatiable but, above all, he was friend, philosopher and guide to many of us, the go-to person for matters, personal or professional, far beyond the academic. A chat with him over coffee or over Zoom during the more recent COVID-19 days was a very comforting experience and often an exhilarating one.

Finally, we will be failing in our homage to Chandru if we do not mention the almost superhuman role played by Chandru's life partner, Yamini in supporting him through his often rather tumultuous health problems, for over the last three decades. On more than one occasion, we found her practical and protective care to be vitally important in ensuring Chandru's welfare and wellbeing, for her steely resolve to take care of his every need disguised her utmost affection and love for him, until, of course, it all tragically gave way on 3 April 2021.

As the second wave of COVID-19 surges over us, we are reminded of Joseph Stalin's quote, "A single death is a tragedy; a million deaths is a statistic." Notwithstanding the many losses that we have suffered over the last year, Chandru's passing away remains an almost immeasurable tragedy for us all. Chandru fought valiantly all his life, if anyone ever did, for the cause of science, for research, for education, for his students and, above all, for the universe of his friends. You live on in us, Chandru, our dear friend, and you always will.

RAGHAVENDRA GADAGKAR

Being conscious that most biodiversity is in the tropics and realising that it was rapidly disappearing, I was itching to do something beyond studying a single species of paper wasp, however interesting. I felt the need to contribute something to the study, if not conservation, of biodiversity.

When I was appointed a lecturer in the newly established Centre for Ecological Sciences at the Indian Institute of Science, Bengaluru, in 1984, I saw an opportunity. Insects were close to my heart, but I was not really equipped to study insect biodiversity. Then I struck gold. Krishnappa Chandrashekara, with an MSc in entomology from the University of Agricultural Sciences, Bengaluru, decided to join me as my first PhD student. Chandru, as we affectionately called him, not only had a vast knowledge of insects, but he truly had an inordinate fondness for insects. Thus began a friendship that lasted until Chandru tragically succumbed to Covid-19 a few weeks ago. It is with a heavy heart that I recount here the fun I had in collaborating with Chandru.

We soon realised that one of the reasons for the paucity of studies on insect species diversity in the tropics must be the lack of appropriate research methodology suitable for tropical conditions. Almost all major long-term insect diversity monitoring programmes were located in well-endowed research facilities and depended primarily on a powerful light trap in operation continuously for years together in the middle of the forest. Needless to say, the uninterrupted supply of electricity is nearly impossible even in our cities, let alone in the middle of the forest.

Raghavendra Gadagkar (RG) was Chandru's doctoral advisor but had associated with Chandru from several years earlier, as he reminisces in his tribute. They both had a deep mutual respect for one another: Chandru for RG's rigour, superb methodical approach to science and deep fondness for scientific literature, and RG for Chandru's immense knowledge of the natural world, infinite patience and diligence during behavioural observations, his geniality and for his sense of fairness and judgement. This respect lasted through the years and realised several salient scientific contributions from the duo.

A locally fabricated, low efficiency, battery-operated, light trap for catching insects. Right: A scented trap; insects are attracted to the fermenting liquid in the bottle and fly in to be trapped. Photos: RG Lab Collection

We built a simple, dismantlable light trap that ran on batteries, worked in the middle of the forest and caught a modest number of insects. We simultaneously employed several other trapping methods such as scented traps, pitfall traps, and net sweeps, which were more labour intensive but could be deployed anywhere.

A pitfall trap that captures insects walking on the ground. Right: Chandru performing a systematic sweep of the vegetation to collect insects in a standardised manner.

Designing these traps and standardising these methods, not to mention conducting the fieldwork, were all intensely pleasurable and gave us great satisfaction. In addition to myself and Chandru, our team consisted of R J Ranjit Daniels, an outstanding ornithologist, D M Bhat, an excellent botanist and Rozario Furtado, who doubled as a driver-cum-field assistant and in many ways was our local guardian. For sampling in the upghat (elevation) sites, we made the town of Sirsi our base camp, and for sampling coastal sites, we made the town of Kumta our base camp. Travelling from Bangalore by overnight buses and spending a week at a time, alternately in Sirsi and Kumta, was an unforgettable and enriching experience.

While not sampling insects in the forests, we sampled life in the two towns, which could not have been more different from each other in the socio-economic status of their people, their dialect, culture and habits. But perhaps it was the food— fat-rich, pure vegetarian, Havyaka Brahmin cuisine in Sirsi and protein-rich, fish and meat-based cuisine of the fisherfolk in Kumta—that made the deepest impression on us. It is impossible to say which we enjoyed more. Travelling, living, eating and doing fieldwork with students and assistants for days together creates opportunities for intellectual camaraderie and a level of social bonding that can never be matched in a 9 to 5 laboratory sitting.

Returning to Bangalore, and with additional help from Padmini Nair and Vijayalakshmi Kandula we examined each collected insect, identified it at least to the family level, and assigned it to a unique Recognisable Taxonomic Unit (RTU). In all, we had captured 16,852 insects belonging to 1789 species (RTUs), 219 families and 19 orders of the Class Insecta.

Thus, we developed and field-tested a package of methods that could be deployed in the remotest places with the barest of facilities and infrastructure, to make reliable estimates of tropical insect species diversity. I am happy to say that our methods have received some attention and are being adopted by some tropical ecologists.

Chandru played a very important part in my early career as an independent researcher. As far as insect biodiversity was concerned, I certainly learnt more from him than he might have from me. It is not

sufficiently appreciated that in the field of ecology, unlike in most other branches of science, PhD students bring along significant expertise of their own, usually in the form of intimate knowledge of, and passion for, a particular group of organisms, to complement that of their mentors. Few could have exemplified this truth more than Chandru. There is a very special kind of satisfaction in working with a student who complements your skills and knowledge, one which most people in other disciplines probably miss out on.

K Chandrashekara showing me around a public exhibition of insects that he had organised along with his colleagues and students in Bengaluru.

Photo: Courtesy H M Yeshwanth

After completing the insect species diversity project, Chandru wrote a fine PhD thesis on social organisation in the Indian paper wasp *Ropalidia marginata* and spent the rest of his life teaching entomology and inspiring students and colleagues alike at his alma mater. During this period, I often had the pleasure of witnessing Chandru's amazing mentoring skills. Seeing Chandru in action, you could never guess whether he was teaching his students, his colleagues or his teachers.

Insects will keep reminding me of Chandru, whether through their beauty or their distress. We must benefit from his tireless efforts at spreading his inordinate fondness for insects through education and outreach. We can pay him no greater tribute.

Chandru and his wife Yamini, during what was perhaps their last visit to our home, August 2019

R J RANJIT DANIELS

I travelled to Sirsi from Bangalore by bus with Chandru in July 1983. We were both travelling to Sirsi to attend an interview called for by the Centre for Ecological Sciences of the Indian Institute of Science for work as Project Assistants in a project that looked at the human impacts on biological diversity in the Western Ghats. While we travelled overnight, near Shimoga, the bus knocked down a wild boar that tried to cross the road and the driver picked up the carcass and sent it by another bus that came the opposite way. We both stood there and watched the entire show in amusement. We had not, however, spoken to one another!

Later in July 1983, we both joined CES as Project Assistants and worked under the guidance of Prof Raghavendra Gadagkar. I vividly remember our first exploratory visit to the lush green forests of the Uttara Kannada district especially those around Sirsi and Kumta, a small coastal town. A team including Prof Madhav Gadgil, Fr Cecil J Saldanha, Prof M D Subash Chandran (from a local college in Kumta), Prof Raghavendra Gadagkar and Prof D K Subramanian were all set to explore these forests. I was there too and along with me Chandru. After this wonderful exploratory trip, we were in November 1983 headed to Mumbai to visit the Bombay Natural History Society's museum and study bird skins. This time the team was smaller led by Prof Raghavendra Gadagkar. Soon after this we joined a field team in Sirsi to start our research.

Chandru and I were assigned the task of investigating insect and bird species diversity in selected plots within different types of forests. Study of insects was time consuming preparing traps to set in the field every night and selecting sampling plots using random numbers. We were based in Sirsi. We rented a part of a house and stayed together for over a year and worked in the field. The Chandru I had acquainted myself with was a soft-spoken, well-mannered person.

Later, in 1985, we registered for our doctorates and were students together at CES. Chandru, during my stay in Bangalore, had taken me around to bookstores, where I had the chance of buying a copy of the 'Handbook of Birds of India and Pakistan' (compact edition) by Salim Ali and Dillon Ripley at a discounted price of Rs 500.

I left Bangalore in 1992 and since have not seen Chandru but have corresponded with him from time to time. The news of his passing away came as a rude shock to me. Long live the memories of the quality time spent with him. May his soul rest in peace.

Ranjit Daniels and Chandru had known one another since the Ecological Research Programme in the Uttara Kannada District commenced in the early 1980's. Ranjit and Chandru both registered for their doctorates together and remained fast friends and colleagues for several years later, sharing their innate passion for natural history and taxonomy, often during seminars and coffee sessions, where exciting and incisive debates produced thinking that frequently pushed the frontiers of early ecological research in the country.

ARUN VENKATARAMAN

Arun Venkataraman and Chandru met at the start of their PhDs at the Centre for Ecological Sciences. From diverse backgrounds and contrasting personalities each learnt to value mutual passions they shared for scientific discovery, natural history, ethics and philosophical issues facing humankind .While Chandru's health permitted they both travelled extensively in the Western Ghats and exulted in the enormous biodiversity value in a place they considered home. On meeting later, their conversations vividly recounted the great times shared together, people they met. enlivened with Chandru's understated humour, that Arun misses so deeply and the splendid biodiversity they both observed, much of it perhaps lost for future generations. Arun was abroad for several years but on his return renewed their conversations with the original fervour and a recall of memory forever etched in their minds

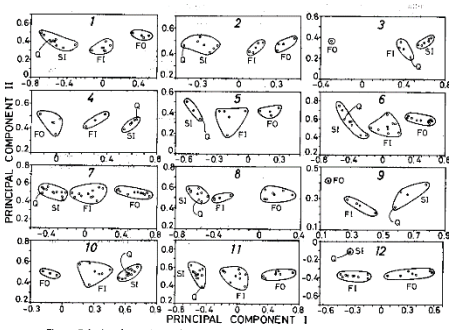
I first got to know Chandru well at Bidarahalla, Sirsi, where CES was carrying out a multi-disciplinary programme to document and conserve the biodiversity of fragmented wet forests in the region. Chandru was leading the sampling of insect diversity and my earliest recollections of him was that of an ardent, lean and scholarly individual weighed down by sampling bottles, nets, field guides and notebooks. Several will remember the award-winning photo of the Ceylon Frogmouth he took there. This photo and the cherished camera he took this with, remained his most valuable possessions for as long as I can remember. Till then I had no formal exposure to field ecology and the next few days remain among the most enchanting in my life. Chandru quickly took me under his wings and spent hours unravelling the complex biodiversity of these forests. Even though relatively new to the field programme, he kept me captivated with explanations on spatial heterogeneity in insect diversity, foraging strategies of bird flocks, the distribution of muntjacs in these forest fragments and an endless repository of other fascinating details of the landscape. In hindsight, Chandru was perhaps one of the earliest influences I had in my lifelong involvement with field ecology. Our bond cemented from those times, remained for decades, when we travelled extensively to several areas in the Western Ghats. Unfortunately, in later years his illness did curtail his travels, but we did spend several hours mentally journeying to those places we loved.

Chandru's insatiable quest for knowledge is evident in his formidable book collection built meticulously over nearly a lifetime. This collection grew from his weekend forays into Bangalore's second-hand bookshops and assiduous searches in bookstores in places he travelled to. Select Bookshop, on Brigade Road, was his favourite haunt and several reading this, will probably recollect meeting him there and speeding off for a hot cup of filter coffee and an animated discussion on his latest find. The older and softer the leather-bound volumes, the more replete with vintage colonial natural history, the more ecstatic he would become. Indeed, it was through Chandru, I developed a fondness for colonial natural history. Even today, my knowledge of the Indian fauna has been shaped through my readings of authors such as GP Sanderson, Dunbar Brander, RW Burton, Edward Blyth, TRD Bell and several others. In reflection, Chandru's profound knowledge and wisdom was quite evolved by the time I met him and continued to deepen through his life. However, his characteristic modesty often hid this facet and Chandru typically demonstrated this knowledge only when it really mattered.

Perhaps the culmination of Chandru's zeal was his role in the development of the Bannerghata Butterfly Park. Chandru always had a passion for butterflies and perhaps perceived this as a watershed moment. The Department of Biotechnology provided a generous grant for him to realise this dream.

The Butterfly Park, when I last saw it more than a decade ago, embodied his vision in butterfly conservation. The park houses a 100 out of India's 400 threatened and protected species of butterflies that complete their life histories through a careful selection of host plants. The park was established in 2007, with grants from National Bio-Resource Development Board (NBDB) and the Department of Biotechnology, through a tripartite project involving the University of Agricultural Sciences, and other agencies. In a visit to the park in 2009, Chandru and his colleagues remarked "The first impression as we walked around the park was a sense of disbelief! We had to pinch ourselves to realise that we had played a part in creation of this beautiful jewel in the crown of Bangalore. Or was it again a case of mind playing its tricks on us!". This reaction was not surprising; the Butterfly Park is truly a trend setter in India's conservation awareness efforts, and we have to recognise Chandru's salient contributions to this unique achievement.

A tribute to Chandru would be incomplete without mentioning contributions from his doctoral research. In a paper published in *Ethology* in 1991, entitled "Behavioural Castes, Dominance and Division of Labour in a Primitively Eusocial Wasp (*Ropalidia marginata*)" co-authored with Raghavendra Gadagkar, they both established a seminal process of social evolution. "Sitter" wasps, which were was those that spent a maximum duration sitting and grooming and "Fighter" wasps, those that showed the highest frequency of dominance behaviour had much more developed ovaries than Foragers, those that spent the maximum time absent from the nest. Queens of most colonies belong to the Sitter caste despite their being no obvious morphological differences across colony members or between apparent behavioural castes. In those youthful days, this result seemed somewhat trivial. However, when one looks back and considers the countless hours across years spent in patient observation, the analytical rigour to tease out these subtle though robust statistical differences and the sheer significance of this result in explaining social evolution, one raises a salute to Chandru for this contribution.



Chandru remained a fast friend of the family till recently. He patiently fielded questions from my son and daughter-in-law on all insects. This was a very pleasant respite for them being stuck with us in Bandipur for over a year due to the COVID pandemic.

In a few cases this led to identification of species recorded in the region only once in the past. They started a WhatsApp group with him a year ago and I recently looked through the posts, enjoying the rich advice he provided. He was a constant source of strength to my wife Anu, who started organic farming a few years ago and frequently queried Chandru on all she read and observed. Chandru never failed to provide sage advice. His only complaint was "Why can't you talk about something else besides agriculture". Yes, Chandru will be sorely missed by several of us. I personally reconnected with him a few years ago after being abroad for several years. I was eagerly looking forward to growing older

together chatting away on science, politics or literature, and reliving all those glorious times shared in the past. What I will miss most is his understated wit – one of his most endearing traits. Rest in peace, my dearest friend!

L SHYAMAL

I went to study at the University of Agricultural Sciences in 1990 because the entomology department had made an impression when on a visit from school, and along with other UAS influences in the birdwatching circle, the common career choices in medicine and engineering were too clichéd for me. The undergraduate agriculture programme was a truly broad programme with some great courses. In the final year, I naturally chose entomology to major in and Chandru turned up to handle our little batch. He said I looked familiar, and I suggested that it would probably be because of my turning up at guest lectures at the Centre for Ecological Sciences, where he had worked for his doctorate. His batchmate, Ranjit Daniels had been my bird-watching guru on the IISc campus where I grew up. Our course was a very open discussion on the history of "pest" management with research topics doled out to us students and the final question paper set by us students ourselves! I then joined a master's programme in entomology but quit to join the Indian Agricultural Research Institute for a less beaten path. During a difficult period, I wrote to him, wondering if I had done the right thing. Chandru responded with a warm letter, which I still preserve, to encourage me on.

Shyamal, a former graduate student of Chandru, continued to seek academic, research and motivational advice from him, years after completing his studies in UAS, an illustration of the lasting bonds that Chandru maintained with all those he mentored and watched over.

Shyamal's account also illustrates how Chandru could convincingly and unobstrusively recruit some of the best and brightest minds into disciplines that are emerging to be of vital importance to humanity. Shyamal is one example but perhaps there are several others he recruited, who went on to make a huge difference to disciplines in natural

Years later, I continued to visit the University mainly for chats-over-coffee with him and our little entomology circle, and at such sessions, he often served as a sounding board for ideas. With the arrival of email and then smartphones, our interactions continued, mainly as short messages, casual links to read, clips to see, and short comments shared both ways. He was a big fan of the internet, having seen it early on at the IISc, and he was very distraught at the failure of the UAS to see its potential or make full use of it. He once told me about how he could not send email via the university account and how it affected the future of students due to the non-acceptability of reference letters sent from personal emails. For him, the division of the University into one dealing with animal sciences, another for forestry and so on was beyond reason. The only explanation, corruption in high places, and that fact that it had not been questioned by civil society greatly annoyed him. Wikipedia tells us that Jihad (English: /dʒɪˈhɑːd/; Arabic: جهاد jihād [dʒɪˈhaːd]) is an Arabic word, which literally means striving or struggling, especially with a praiseworthy aim. I would describe Chandru as an Education-and-Research-Jihadist and I think he would have laughed with gusto at that usage, especially for its potential to rile the religiously bigoted! He just could not accept the declining state of the University, one with petty rivalries, quests for power, money, and promotion, and a declining interest in science, research or teaching. There were good periods in the university when someone in power was willing to listen to his ideas but at other times, decisions made without proper dialogue irritated him no end. He was not one to worry about speaking his mind regardless

of what effects it might have. He would not suffer fools and was quick to point out faults, a trait that his reticent colleagues admired at a staff condolence meeting that I snuck into.

Chandru always believed that better institutions could exist and was always examining models, their cultures and policies. He envied the resources of next-door NCBS and sought greater academic freedom. The School of Ecology and Conservation was perhaps an attempt in that direction. It allowed him to pursue the Butterfly Park project.

Chandru's vision for the Bannerghatta Butterfly Park included the potential to independently fund and support high quality research. He often pointed out how the University could perform better and even fund itself better by trying out ideas, some already demonstrated within the same university, such as in the bakery training centre which conducted a very popular training course open to anyone. He took a historical view of things and was involved in the founding of a lecture series to commemorate the birth of Leslie C. Coleman each June 16th.

MR. LESLIE C. COLEMAN, Mycologist and Entomologist to the Government of Mysore is expected to arrive in India in September. He is at present at Goettingen University, in Germany, where he will probably take the degree of Doctor of Philosophy.

Coleman was a pioneer of agricultural entomology in Mysore and several of us shared an admiration of his work and writing - when I shared my discovery of Coleman's reflections on the Khaki University – an ersatz university for Canadian soldiers in Europe during World War I – it struck a chord:

> *"Two things have been impressed upon me by my work ... as never before. One of these is the comparatively insignificant part University Buildings and equipment play in the development of mind and character. The other is the importance of educational work among men who have passed what is generally considered the school age."*

To celebrate Chandru's retirement in November-December 2019, the Entomology Department organised a three-day insect exhibition for the public.

On one evening, we had talks by his colleagues R Uma Shaanker, K N Ganeshaiah and others. Present also were Chandru's mother and wife, Yamini. One of the revelations to me was that he had been a key in the establishment of the Friday and Tuesday Evening Groups, two informal forums at the UAS for talks and interactions on a very wide variety of subjects. The insect exhibition was one of several that he has been involved in, the first one as a student, having been conducted at the Visvesvaraya Industrial and Technological Museum in February 1979 by a small group as a part of another exhibition on birds. The sub-exhibition was so popular that it was expanded and had to be run for 16 days attracting 30,350 visitors according to the Annual Report of the Museum. I remember Chandru noting that one of the visitors at the exhibition was Dorothy Hodgkin, then a visitor to IISc. I surprised Chandru and others with the discovery of a news clipping on the Mysore Dasara of 1912, which reported on a novel and popular section – an exhibit on insects of agricultural importance organised by Leslie Coleman!

As a teacher, Chandru encouraged independent learning and was against any form of spoon-feeding. He got students to explain things on their own and forced them to refine ideas with tricky and challenging questions. He encouraged non-formal approaches such as exposing students to the general public at exhibitions or in interactions at the Krishi Mela.

He loved the field as a place of learning although his poor health came in the way. He loved to introduce paradoxical observations to elicit explanatory hypotheses, invariably leading to discussions on ultimate and proximate causation – I still remember his example, though not in a classroom, of leaf-cutter bees and their tubular cavity nest with the first cells and eggs placed deep and growing outwards but with the last eggs in the outermost cells hatching first. He loved clever experiments and enjoyed questioning terminology, seeking precision in them. One of his most influential contributions was a novel course on insect behaviour with a strong emphasis on experimental approaches, with inspiration from his post-doctoral work with Mandyam Srinivasan at the Australian National University in Canberra, Australia.

Chandru was a DIY fan and was a collector perhaps of little tricks and ideas in entomological experimentation and research. He despised dog-in-the-manger attitudes of anyone controlling access to microscopes, computers, or other resources and it is perhaps unsurprising that one of his first actions at the University was to improve student-access to microscopes and computers. He was all for radical

experiments, such as the open-source software movement, supporting me early in 2006 to enrich Wikipedia with photographs of butterfly life-stages taken as part of the butterfly-park research, adopting the use of R for statistics, and recommending OJS for the management of the *Current Science* journal. His DIY extended to building construction and he was meticulous about the design and detail of the structures for the Butterfly Park. He was aghast at professional engineers and architects, who could not account for the magnitude of rainfall on the roof and would compute the size of drains to manage runoff on his own. He had a keen eye for such critical minutiae.

Chandru loved clever phrases and wit, and a perusal of his tweets will stand testimony, although the best place to catch his one-liners was at student seminars and lectures. I can still remember his laughter at my term "captive journal" to refer to *Current Science*, a journal for which he served as an editorial team member. He was truly a champion of interaction across disciplines, I remember his question, half in jest, to Bert Hölldobler some years ago, asking if the study of ants might have any learnings applicable to university administrators! He read widely, interacted with a wide range of people, responded to anyone who contacted him and, in many ways, acted as *the* unofficial science ambassador for the UAS.

Not a day has passed when I have not wanted to send a link, a snippet or an interesting paper just to hear Chandru's sharp comments. He will be sorely missed by many of us. We wish his family, friends, and students all the strength to bear the loss.

SANJAY SANE

By my feeble reckoning, it was a breezy afternoon in September 2007 when I dropped in unannounced into Chandru's office. I had just spent a morning on the phone with Bannerghatta Park officials, requesting to know about their Butterfly Park, and if they could show me how their butterflies were bred. I needed help with identifying a good study system – a butterfly or a moth – with which to start insect research in my fledgling one-month-old laboratory at the National Centre for Biological Sciences (NCBS). I half-expected to have to make long trips to Bangalore University, located at the other end of town, but was in for a surprise. "You must talk to Prof Chandrashekara from the Gandhi Krishi Vigyan Kendra" they said. This was a short walk for me, for my institute was situated within the GKVK campus. It had taken me a tortuous path to find my nearest neighbour! Overcoming my usual inertia for seeking help, in this instance I got up and walked to the GKVK, past the lunch-going students and staff of the bustling university, and entered the Entomology Department, and into the office of "Dr Chandrashekara". I will always recall that meeting vividly: I introduced myself as a new faculty member at the NCBS, interested in insect behaviour and neurobiology, and desirous of working with moths. He mentioned that he too was interested in insect behaviour. His PhD was from the lab of Prof Raghavendra Gadagkar – insect behaviourist par eminence – and his postdoc with the great Australian-Indian scientist, Prof Mandyam Srinivasan. We clicked right away as we began discussing fun insect behaviour questions to work on. The conversation was unhurried. He was not looking at his watch, and not once did I feel that I had intruded. Somewhat diffidently, I mentioned that I had planned to continue my work using an exotic moth species (*Manduca sexta*) but had lately decided that this would be a bad idea, as containment would forever be an issue. Could he help me identify a local hawkmoth species instead of *Manduca*?

Sanjay Sane's account of Chandru illustrates the depth of Chandru's ability to pose scientific questions, recognise frontline research and then, with meticulous attention, provide patient and pragmatic advice to support the research he catalysed. In today's world with all the attention given to charismatic megafauna and threats faced by their habitats, it is refreshing that Chandru encouraged and motivated a body of scientists, who maintained his legacy of exploring the fascinating biology and ecology of lesser-known taxa, which still offer scientific findings of huge importance for both mankind and its attempt at finding sustainable solutions to its ever-increasing

Chandru exuded a kind of warmth and welcome that is increasingly rare in academic circles. People are busy, visitors, especially those unannounced, are a pain. But here was Chandru telling me, "Oh, Dr Sanjay, you are in Lepidopteran heaven!". He pulled out his collections – several trays of hawkmoths that he had collected on the GKVK campus – and said to me "All of these were collected on the campus. You could work with any one of these". I was stunned to see this collection – my very first glimpse of the rich biodiversity that Bangalore and the Indian Peninsula had to offer. Not being a hawkmoth naturalist, I asked him – again diffidently – "Could you suggest a moth that would be good to work with? It needs to be a robust system that I can stick electrodes in, and which I can see flying around in the backyard, and

which I can breed in the lab". With a big smile, he said, "In that case, I would recommend this hawkmoth" and pointed to an utterly lovely creature, the oleander hawkmoth *Daphnis nerii*, that looked like a hawkmoth in fatigues. Thus began my association with *Daphnis nerii*, which to this day remains the main workhorse of my research.

When I needed to hire an assistant for insect breeding, Chandru suggested the name of Kemparaju, who he had spent years training. "I am unable to pay him a better wage due to university rules, but if you can, then he is your man. In fact, he's the one who helped me with the Butterfly Park". In due course, I hired Kemparaju, who helped set up my *Daphnis nerii* breeding programme.

Chandru at Moth Day 2019, enjoying the sight of curious school children with insects

It thus took an afternoon, an act of impulse on my part, and Chandru's boundless generosity to set up my career there onwards. Adopting *Daphnis nerii* was not easy – I ran to Chandru whenever the colony collapsed or ran into teething problems, or if there was an infection that caused larval mortality. Each time that happened, Chandru would personally oversee the culture and troubleshoot my problem. My problems were his problems. From these beginnings sprang my friendship with Chandru, which lasted until his sudden passing on April 3rd, 2021. To me, our friendship was a highlight of these years. I looked forward to every meeting with him. Aware of my own shortcomings as an entomologist, I sent students to Chandru and his colleagues to the Entomology Department for training in insect identification and taxonomy. The entomology group at GKVK ran a superb course, which trained several of my students, many of whom will carry that torch forward. My students would drop into Chandru's office from time to time, sure to receive the same warm welcome that I had had from him. We thought of different ways to bring together various insect groups in Bangalore to meet one other and form a community, including a regular meeting called IBIG (Insect Biology Interest Group), and various outreach events, such as Moth Day in which he heartily participated, and several such as Kitavismaya and annual Krishi Mela, of which he was an integral part. I greatly enjoyed hanging out with Chandru when he had spirited discussions with his colleagues (and best friends) over tea at the Entomology Department. I envied their camaraderie – critical, passionate and unfailingly warm. And their science was top-class. When he retired as the Head of the Entomology department, his students and colleagues organised a superb exhibition of insects in his honour.

In recent years, I worried about the decline in Chandru's health due to a lung ailment that had taken a turn for the worse. But his enthusiasm and intellectual vigour did not flag even one iota. He would discuss ideas sometimes until he struggled for breath. In personal conversations, he'd sometimes sheepishly confess that he often overexerted himself and landed up in the hospital, much to the chagrin of Yamini, his rock of Gibraltar.

Such news was always communicated with a trace of self-deprecating humour. I'd gently admonish him, as I suspect many of his friends also did – but we had no hope to contain his enthusiasm. His pace of walking had slowed down considerably and even a small exertion rendered him breathless.

Despite this, he participated in thesis committee meetings, the NCBS Chemical Ecology Programme, and his own hectic teaching schedule. We met each other as often as we could. Any visit from Chandru was a special occasion. I dropped whatever I was doing when occasion presented itself to have long conversations with him. On my usual walk to work, I would often be asked by passing colleagues if I needed a ride, and I'd wave them off because I needed the walk. If, however, the person offering the ride was Chandru, as he often was, then I would not hesitate to accept it because that meant a chance to chat with him.

Typically, we'd end up chatting at length unless he was rushing for a class. Our topics would always hover around insects, new results from the lab, articles that he had read, scientific philosophy, latest example of pseudo-scientific nonsense, Haldane, Wilson, Thomas Kuhn, experiences from old field trips etc. My lab mates too would brighten up to see Chandru and would discuss their results with him. With every conversation came new light and wisdom, and research ideas and approaches. Standing by his side as he had these conversations, I came to deeply admire Chandru's vast erudition and his ability to connect our observations with something he had seen in the field, or in other insects. His mind constantly sought to see the larger picture, in terms of comparisons and evolution and in the process, new projects presented themselves. He also thought deeply about the philosophical issues about scientific methodology. I got excellent advice from him about moth sampling techniques. He was well-versed with several ways of collecting insects, and what would best suit the conditions that we were working under, the conditions and pitfalls to expect. These discussions and his encouragement helped me put together a long-term survey of hawkmoths in Agumbe, which continues to this day.

Chandru and Srini (Prof M V Srinivasan) visiting my lab in 2016

My very final series of conversations with Chandru were conducted from the beginning to middle of March 2021, on text. Much as I wanted to meet him, I worried that he was vulnerable and so preferred instead to talk to him on phone or text. These conversations were about an interesting type of fly that I had stumbled upon in Pachmarhi in Madhya Pradesh. They hung out on floating leaves and guarded these territories with great vigour. When an interloper landed on the leaf, there would be a face-off involving a series of dance-like movements culminating in one fly flying away. When I saw this, the first thought that came to my mind was “I must tell Chandru about this!”. That evening, I called him and we had a long conversation about what this fly could be. I sent him pictures and videos. “They are either shore flies or stilt-legged flies” came the response the following day. We eventually converged on stilt-legged flies. His excitement for the videos I sent him was palpable. He suggested a few books and references on mating systems in insects, which I promptly followed up. Our last conversation lasted more than an hour, and we discussed the flies, and mating systems of insects. He also informed me that his son, Karthik, had got into a wonderful doctoral programme at Heidelberg. There was an understated pride in his voice as he told me how happy and satisfied, he and his wife Yamini were with this development. It was, as always, a happy conversation. I consider it my immense luck to have entered Chandru’s orbit at an early stage in my academic career. He exemplified all that is noble about a scholar’s life: openness, boundless generosity, wisdom, scepticism, and an unconditional love and empathy for other earthlings, including of course, insects. Chandru leaves behind a formidable intellectual legacy. His spirit will smile upon the joie de vivre of our entomological pursuits, and when we throw open our offices to early-career scientists and students. Only by being available for others as he was for us and by taking joy in their success as he did in ours, can we pay forward the immense debt and gratitude that we owe him. I cannot think of a more fitting way to honour his legacy.

GEETHA IYER

My first meeting with Prof Chandra – despite being a great friend, it's how he first pops up in my memory – is still fresh in my mind. In the corridors of the entomology department at GKVK, he strode up to me with a boyish smile, saying, "I like your book". Not many people have said that to me – who likes a book on insects? – and just like that we became friends. For the next half hour of my interval time from the taxonomy training, there was so much conversation, most of which I have forgotten, the only memory remaining is of my thought, "Wow, why am I meeting this genius only now!" The impish look on his face and the sparkling eyes, so full of energy, were his trademark, for never had I met him with any other countenance.

For the rest of the duration of my time at GKVK, I talked to him on and off as my training took most of the time and come evenings, we were locked away in the girl's hostel. Fortunately, the series of seminars at NCBS gave an opportunity to be free in the evenings; accompanying him for the talks, I recall how I really lapped up everything he had to say. He recommended Karl von Frisch's "Ten little House Mates". That weekend, my friend and I searched and found it in, where else but, Blossoms, the best bookstore in Bangalore. He told me I should attempt to write about the less exotic creatures. The time spent talking about evolution, as we walked down for the meetings, will remain among the highlights of my life's experiences. I never failed to chat with him whenever I visited GKVK, in fact I looked forward to it. I could go on and on.

He has been described in many different ways by people whose lives he touched, just as he did mine. For me, however, he remains a metaphor for wisdom.

Geetha is an author, writer and an independent consultant. It is evident that her conversations with Chandru on a vast array of subjects, were cornerstones in her writings and influenced some very progressive thinking in entomology and allied disciplines. Their relationship also epitomised the liberal and free-thinker Chandru was, giving time and attention to pursuits beyond academia to the popularisation of the wonders of the natural world. Obviously, Geetha learnt this fast and sought the best in Chandru.